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The Design of Granary Environmental Monitoring and Control System Based On ARM9 and ZIGBEE

Hemanth Kumar G, Manjunath lakkannavar

Abstract*: Grain storage is a vital component in the economy and the society. The quality and safety of grain storage are related to the hundreds of millions of people. In the process of grain storage, temperature and humidity are two major ecological factors that can affect the grain quality. Therefore, the parameters of temperature, humidity must be in accurate and real-time monitoring by supervisory systems in large granaries. The automatic monitoring of the grain storage will help us to improve the operation levels of grain storage, reduce the grain losses during stored procedure and reduce labor intensity. This project designs an environment monitoring system of the granary combining Embedded and ZigBee wireless sensor network technology. Using ZigBee wireless sensor network to complete acquisition and transmission of environment parameters and using ARM9 to achieve precise control of the barn environment as system data controller and using GSM to achieve the system's remote control, it greatly improves the flexibility and scalability of the warehouse management which sends available data to grain depot manager (Database management) in time and filters invalid data on the spot. It makes many important aspects not need manager to complete on the scene, which saves a lot of manpower and material resources and improves labor productivity.

Keywords: ARM9, MINI 2440, ZIGBEE, GSM,Visual studios,

I. INTRODUCTION

Grain storage is a vital component in the economy and the society. The quality and safety of grain storage are related to the hundreds of millions of people. In the process of grain storage, temperature, CO2, humidity, light intensity are the major ecological factors that can affect the grain quality. Therefore, the parameters of temperature, humidity, CO2, light intensity must be in accurate and real-time monitoring by supervisory systems in large granaries. The automatic monitoring of the grain storage will help us to improve the operation levels of grain storage, reduce the grain losses during stored procedure and reduce labor intensity.

This project designs an environment monitoring and control system of the granary combining Embedded and ZigBee wireless sensor network technology. Using ZigBee wireless sensor network to complete acquisition and transmission of environment parameters and using ARM9 to achieve precise control of the barn environment as system data controller; and using GSM to achieve the system's remote control, it greatly improves the flexibility and scalability of the warehouse management which sends available data to grain depot manager (Database management) in time and filters invalid data on the spot.It makes many important aspects not need manager to complete on the scene, which saves a lot of manpower and material resources and improves labor productivity.

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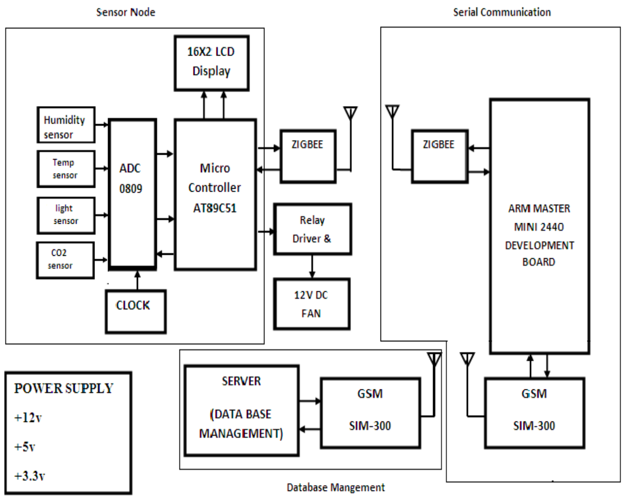
II. PROPOSED SYSTEM



The sensor node is responsible for collection of environment information (such as temperature and humidity). The signals collected by the sensor through the a/d conversions are sent to MCU processing. The microcontroller is connected to LCD to display the values of temperature humidity, CO2 and light intensity. Controlling part is also included in the module by connecting the 12volts dc fan to the microcontroller through the relay driver and relay which controls the fan. The Zigbee communication module changes the data into data packets of zigbee communication protocol which are transmitted to the coordinator node. The coordinator node after receiving the data packets from the sensor node performs handshake communication by sending a confirmation language source to the sensor node to complete a full Zigbee wireless communication process. On the other hand it should upload the data to the ARM master unit through the serial port. The ARM master unit gathered the collected information data. The information collected by the ARM master is sent to warehouse data management system through the GSM network through serial Communication.

A. Mini 2400

The MINI2440 Development Board is based on the Samsung S3C2440 microprocessor. Its PCB is 4- layer boarded, equipped with professional equal length wiring which ensures signal integrity.

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MINI2440 boards are manufactured in mass production and released with strict quality control. On startup it directly boots preinstalled Linux by default. There are no extra setup steps or configuring procedures to start the system. It is easy for users to get started. Anyone with very basic knowledge about the C language can become proficient. FriendlyARM. Mini 2440 with 400 MHz Samsung S3C2440 ARM9 processor. [3]The board measures 100 x 100 mm, ideal for learning about ARM9 systems. On board 64M SDRAM and NAND Flash,2M NOR flash with preinstalled BIOS, 100M Ethernet RJ-45 port (powered by the DM9000 network chip), The MINI2440 development board currently supports Linux 2.6.29 and WinCE.NET 5.0.Final Stage

B. S3C2440

SAMSUNG S3C2440 uses 16/32 bit ARM920T RISC technology for the core. Its main Frequency is 400M Hz. It provides a camera interface (camif) to support camera. There are two models for camif to transmit data with DMA controller: one is called Preview mode, which transform the image data sampling from the camera interface into the RGB format, and transfer it to the SDRAM under control of the DMA; the other is called code mode, which transmits the image data to the SDRAM in YCbCr4:2:0 or 4:2:2 format.[5]

C. Temperature Sensor

Temperature sensor is connected to “channel 0” of ARM7 microcontroller. This sensor gives a variable output voltage with respect to the temperature variations in a greenhouse. The LM-35 is used as temperature sensor which is a precision integrated circuit temperature sensor, calibrated directly in ° Celsius (Centigrade), Linear + 10.0 mV/°C scale factor with accuracy 0.5°C (at +25°C) with rating ranging from -55° to +150°C range. Here we have to set the minimum temperature and maximum temperature values.

D. Humidity Sensor

Humidity is the quantity of water content in atmosphere. Humidity sensor is connected to “channel 1” of ARM7 microcontroller. The sensor output is a variable voltage with respect to humidity level and expressed in terms of %. The SY-HS-220 humidity sensor is used which converts relative humidity to the output voltage with operating humidity range 30% - 90% RH and accuracy is ± 5% RH (at +25°C). In normal condition the humidity will be around 50% to 70%. Here, we have to set the minimum humidity and maximum humidity values.

E. Light Sensor

Light sensor is nothing but a light dependent resistor (LDR) in which the resistance will vary with respect to the light intensity that falls on it. Light sensor is connected to “channel 2” of ARM7 microcontroller. LDR is a variable resistor and its output will be read in terms of lux. The light dependent resistor is used to detect the light intensity. This sensor will give a variable output voltage with respect to the light intensity variations in a greenhouse. It has two cadmium sulphide (cds) photoconductive cells with spectral responses. The cell resistance falls with increasing light intensity and it can detect the minimum light intensity i.e. moonlight 0.1 lux.

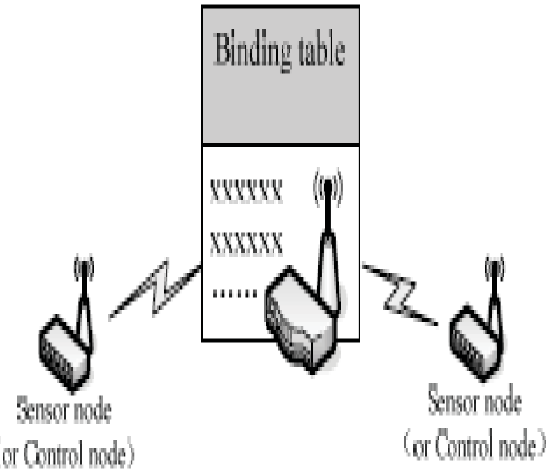
F. CO2 Sensor

This sensor is used to sense the concentration of CO_2 in a greenhouse. This sensor is also used as gas sensor to detect the smoke if occurs in greenhouse. CO_2 sensor is connected to “channel 3” of ARM7 microcontroller. This sensor will give a variable output voltage with respect to the variations of CO_2 concentration in a greenhouse. MQ-7 sensor is used as CO_2 sensor which has high sensitivity to LPG, natural gas, sensitivity to alcohol, smoke. The CO_2 concentration detection range is 200ppm to 10,000ppm.The concentration of CO_2 can be expressed in terms of PPM or in percentage.

III. SYSTEM SOFTWARE DESIGN

A. Software design of ZigBee wireless sensor network

The achieved network topologies of ZigBee wireless sensor are star, mesh and cluster-like networks. The system of this paper uses star network topology. The ZigBee protocol stack is TI's Z-Stack protocol stack [1,6]. Star network topology consists of a network coordinator and a number of network terminals. Among them, the network coordinator is the core of the network. Its main role is to create networks and the configurations relating to network,such as helping to establish the security layer of the network In this design, it must establish a binding table entry at the end of the coordinator before any two nodes to communicate.



The role of coordinator is to maintain the binding table and forward packets. Figure shows the form of indirect binding instructions of endpoints. In this design, use of indirect binding to establish a binding table. When there are data communication requests in the two bound sensor nodes, the coordinator will forward automatically basing on the binding table. If the bound nodes are not in the network, the coordinator will write data to the temporary buffer. After the binding nodes add to it, it would forward. If the buffer is full, the oldest data packets are automatically discarded. Based on the analysis of above tasks, we create the following three tasks to complete the system: TaskesMain, ZigBee to Com, Com to ZigBe. TaskesMain will realize the protocol stack initialization, network connection maintenance,task initialization and call. ComtoZigBee will package the data that is send from the serial port through ZigBee protocol then sent to the ZigBee wireless network. ZigBeetoCom’s mission is to send the data that transfer from ZigBee network to the serial port through the ZigBee protocol resolution, hand in the ARM host controller.

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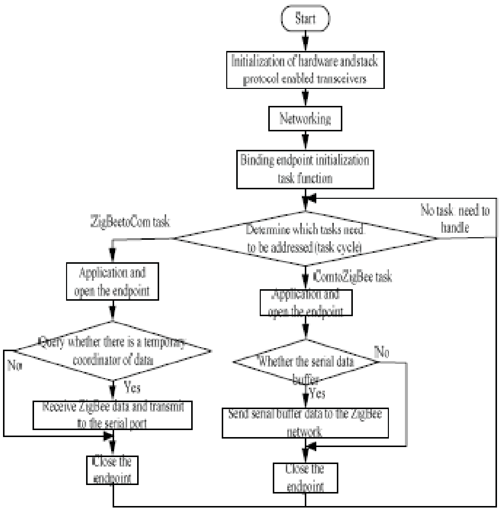

Figure 2. Flow chart of ZIGBEE network Co-Ordinator

B. Software design of ARM host controller

The overall software structure of the ARM main controller is shown in Figure 5. The system adopts Linux as the operating system of the ARM's main controller. The work needed to be done is: the cutting and transplantation of Linux 2.6.32, the programming of the serial driver, the programming of touch screen driver, the implementation of Web server and the migration of Visual studios database, the system also adopts of the graphical user interface based on QT/E and establishes a QT user interface to optimize the human-computer interaction environment.

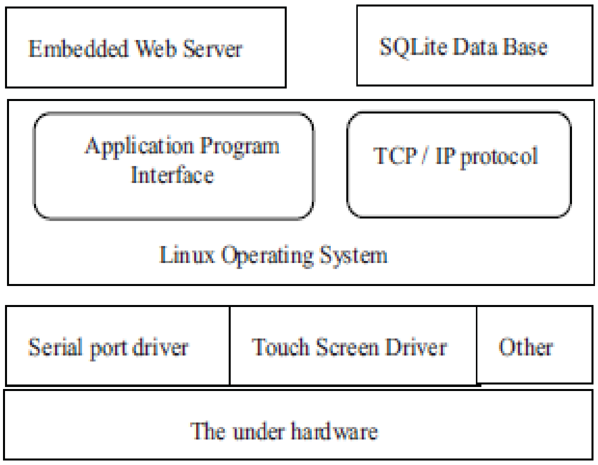

Fig : Overall structure Of the system

Linux Operating System Figure 5. The overall structure of system software of ARM data control module Remote communication module is mainly made of three parts, the GSM wireless modules, SIM card and the serial port module. The ARM main controller uses the AT command to communicate with GSM module through RS485 interface.The working principle: ARM main controller processes protocol encapsulation of the data which is collected from the ZigBee sensor network, then sends the data packet to the GSM module through the RS232 interface. At here the data is packaged into TCP / IP packet, finally the GSM module sends the data to the GPRS network, and then sends the data to the data management center through various gateways and routes. Application Program Interface TCP / IP protocol Embedded Web Server Visual studios Data Base Serial port driver Touch Screen Driver Other The under hardware.The AT command code of the landing GSM network are as follows:

AT+IPR=57600; //Set the baud rate of serial communication is 57600bps.

AT+CGDCONT=1,"IP","CMNET"; //Initialization of GSM module. Set the access Gateway of GPRS. If it returns "OK",the initialization is successful.

AT+CGCLASS="B" // Enable it with the capabilities of GSM and GSM voice.

The category of the mobile terminal is Class B.

AT+CGACT=1, 1, // If it returns OK, it indicates that GSM network connection is successful. Finally, it sends the command "ATD * 99 *** 1 #" to connect GSM network to the Internet.In addition, using visual studios databases to the collecting storage information in the system is to provide the theoretical basis of managing storage environment to the user. The database has a series of advantages: powerful, simple interface, fast, small size and so on,so it especially applicates in the embedded systems. In this system, the version of the database is visual studios 6.0.

C. flow chart at the sensor node

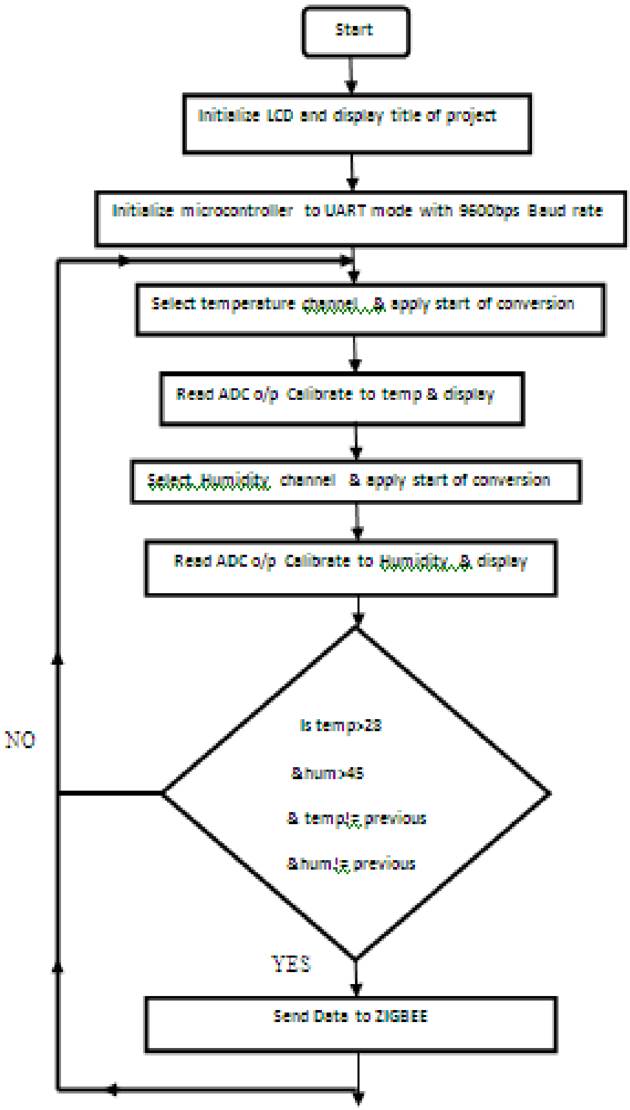

Figure : flow chart at the sensor node

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D. flow chart for serial communication

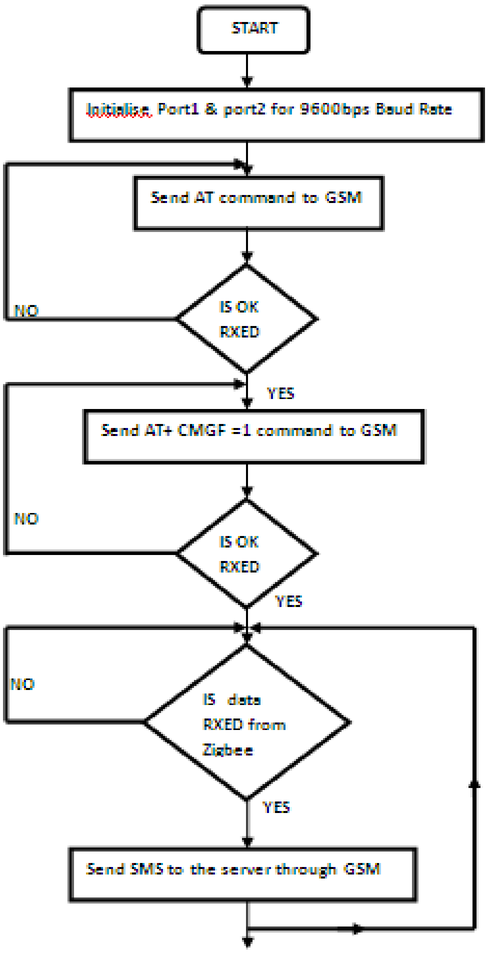

Figure : flow chart for serial communication

E. Flow chart for database management

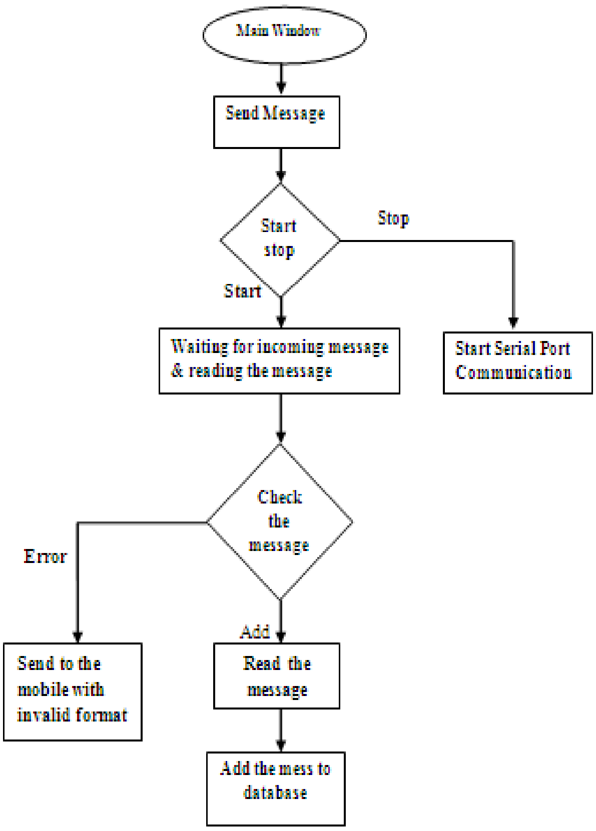

Figure : Flow chart for database management

IV. RESULTS

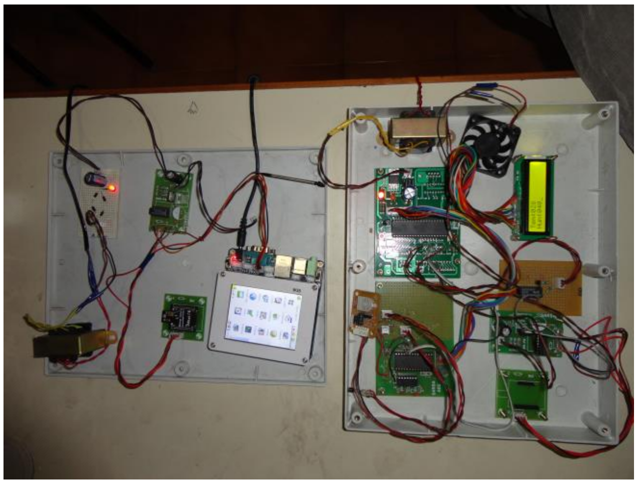

Figure : showing Complete hardware module

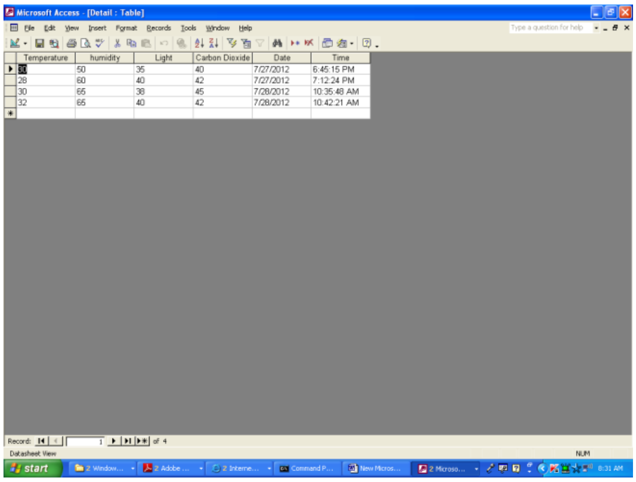

Figure showing Database management

The monitoring part, controlling part and the database management is shown in the above figures. In this Paper the maximum of 40' Celsius temperature and 70% of humidity is set, if the temperature and humidity crosses the above mentioned level, controlling part of the circuit starts working. Whereas the LM35 measures a temperature range of -55 to 150 degrees Celsius. At room temperature, the LM35 has a typical accuracy of plus or minus 0.25 degrees Celsius, and plus or minus 0.75 degrees Celsius over the full temperature range. Similarly Humidity Sensor SY-HS-220 has a related voltage of DC 5.0V, related power <= 3.0mA, Operating temperature from 0 to 60' Celsius, Operating humidity From 30 to 90 % RH, Storage humidity Within 95% RH, Storage temperarute of -30 ~ 85`Celsius, Standard output of DC 1,980mV (at 25'c 60% RH) & Accuracy +/- 5% RH (at 25'c, 60%RH).The monitoring of this proposed work is efficient as its sensitivity of the controlling module, for exceeding temperature catch around a second.

V. CONCLUSION

This project work aimed at designing granary environmental monitoring and controlling system with superior performance, clear structure and good scalability.

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The project is based on the integrating with ARM control technology, ZigBee wireless communication and sensor technology. The system will show the GSM network has the capability of fast packing and transferring data, it can guarantee the data collected transmitted to the user management center real-time, to ensure that the user can barn environment timely and make the right decisions. The system not only saves the energy consumption significantly, but also reduces a large number of inputting on the human and material resources in the management. Applying embedded technology and ZigBee wireless transceiver technology to the rapid deployment system of the incident detection of emergency food storage environment without complicated connections, it enhances the system's flexibility, small size, low cost and good effective, so it is easy to install and migrate.

VI. ACKNOWLEDGMENT

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